

Operational Issues from the Stations



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Introduction

- ◆ **Stations asked to compile list of**
 - ◆ Factors limiting their performance
 - ◆ Originating at the stations
 - ◆ External limitations
 - ◆ Important improvements recently performed
 - ◆ Proposals for external improvements (i.e., in the ILRS network)
- ◆ **Received 13 answers**

Borowiec, Changchun, Graz, Herstmonceux, Moblas 5 (YARL), 6 (HARL) ,8 (THTL), MLRS (McDonald), Riga, San Fernando, SALRO (Saudi Arabia), Simosato, Zimmerwald



Limiting Factors at Station (1)

- ◆ **Outmoded and failing equipment**
 - ◆ Pulse length (< 100 ps)
 - ◆ Laser output power stability
 - ◆ Counters/timing
 - ◆ Accuracy, rate, interval counter vs. event timer
 - ◆ Detectors
 - ◆ Accuracy, time walk



Limiting Factors at Station (2)

- ◆ **Signal detection, processing**
 - ◆ Daytime noise (esp. with weak targets)
 - ◆ Beam polarization in Coudé path
→ Azimuth/elevation-dependent link budget
 - ◆ Difficulties with weak targets (esp. during daylight): GLONASS, Etalon, GPS
 - ◆ PMT time walk: Difficulty to measure/correct



Limiting Factors at Station (3)

◆ Tracking

- ◆ Pointing accuracy
 - ◆ Encoders, alignment of axes, mount models
- ◆ Distortions because of sunlight on the mount

◆ Communication

- ◆ No access to updated time bias function or realtime time bias



Limiting Factors at Station (4)

◆ Miscellaneous

- ◆ Funds, manpower, spareparts
 - ◆ A subject raised by the majority of stations
- ◆ Environmental problems
 - ◆ Dust, frost, mist, condensation
→ Ventilation, heating, protections
- ◆ Software shortcomings
 - ◆ e.g., w/r to drag and time bias values



External Shortcomings

- ◆ Some **midnight problems** with **daily IRVs** (HTSI)
- ◆ Occasional problems with **quality of LEO IRVs**
- ◆ **Low link budgets** on GPS, Glonass, Etalon
- ◆ **Connectivity** to prediction information (Time bias functions or values, maneuvers)



Recent Important Improvements (1)

- ◆ Aircraft avoidance radar permits single observer operation
- ◆ Daily IRVs
- ◆ Predicted time bias download, display or integration into software
- ◆ Realtime exchange of time bias information
- ◆ New equipment: CSPAD, counter or event timer, GPS timing, telescope drives, ...
- ◆ Improved crew training



Recent Important Improvements (2)

- ◆ **System support for operators** w/r to
 - ◆ pass scheduling and pass selection
 - ◆ calibration scheduling and interpretation of results
 - ◆ laser power / signal strength management
 - ◆ satellite acquisition
 - ◆ post-processing
- ◆ **Automation**: From mere support to autonomous actions



Recommendations towards ILRS (1)

- ◆ Unify IRV file format (ftp download)
- ◆ Calibration of timing devices against standard (→ EUROLAS)
- ◆ Web-based collection of hints and tips for devices widely used by ILRS stations
→ NW&E Working Group



Prediction Files at EDC

```
! START OF IRVS
NERCDY_AJI266          0
 2002  9 23  0  0  0.0  -5930986.378062    4557441.161115   -2448640.197364
 1500   266    4    -3884.077862206   -2395.253429556    4986.882489176
      0    0   -34    3770.0   -3822185.500000   -1292.448852539
! END OF IRVS
```

```
IRVSHTSI      TUNED IRVS
 2002  8  1  0  0  0.0    7608097.050551    1974295.822622    154648.893863
 1500   213    0   -1108.532749246    3850.164541910    5458.391817618
      308   329    0    4361.0    9737041.767036    8200.023610281
```

```
IRVS_ESOC_ENVISAT_ROUT
 2002 10 06 00 00 00.0    1252816.403538    501127.503409   -7042553.030605
 6179  274  112    6377.792310622   -3897.535159926    857.242359962
      188   191    0    8962.0   -5288609.123658    3337.499510658
.
```

To: SLR Stations
Fm: GFZ Orbit Prediction System
Op: Automatic Generation

```
DSIDP CHMP.ORB.PRD  IRVS          A 021002
GFZ_FITXYZ_950221_IRVS
 2002 10  2  0  0  0.0   -4427618.163102   -1297075.679388    4942818.932048
 8002 1854    1    5440.488197758    1384.110189531    5224.448510884
      198   199    0    12268.0   -781874.910442   12049.046898173
```



Recommendations towards ILRS (2)

◆ Software validation

- ◆ Prediction recovery from IRVs
- ◆ Time bias and drag corrections
- ◆ Conversion from earth-centered to topocentric vectors
- ◆ Calibration corrections including terrestrial refraction
- ◆ Normalpoint generation



Recommendations towards ILRS (3)

- ◆ **Data quality feedback**
 - ◆ More frequent / more up-to-date feedback
 - ◆ Station-dependent
 - ◆ Identical format for similar reports
 - ◆ Validation across the various similar reports
How many similar reports do we need?
 - ◆ Access to pass residuals
(+epoch, azimuth, elevation)
 - ◆ Web-based



Weekly Pass Reports

Subj: No.2105 : crl bias report 20020819-14d

```
#
# 7810 = ZIMMERWALD
# sat site      date  time dur   rb mm   error      tb us   error   prec bad total  rms   pres  temp hum  sdelay shft  rms cfg r wlen
LAG2 7810 2002/08/22 04:18 26    -5 (   8 )    9.1 (   5.1 )    3  0 / 13  24  913.6 284.4 99  12464  0  30 7 0 0  846
LAG2 7810 2002/08/22 04:19 32    -4 (   7 )    8.5 (   4.4 )    3  0 / 13  21  913.6 284.4 99  12145  0  17 7 0 0  423W
```

Subj: No.2106 : CSR Lageos-1 & Lageos-2 Residual Analysis, 04 Sep 2002

```
STA  AVG PASS TIME  SAT  GOOD RAW PREC  RANGE  TIME PASS EDITED  CALIB+  CALIB  CALIB++  STPASS
ID   YY/MM/DD HH:MM  OBS  RMS  EST  BIAS  BIAS  DUR  OBS  MEAN  SDEV  SHIFT  RMS
      (MM) (MM) (MM) (US) (MIN) (MM) (MM) (MM) (MM)
> (7810) ZIMLAT at Zimmerwald
7810  2/08/22  4:31 L2  26  12  4  19  9  33  0  12145 I  17  0 P  21
```

Subj: No.2113 : MCC LAGEOS Weekly Analysis Report

Zimmerwald (7810 NP)

```
DATA  T ini T fin SC  TTL  INC  ME  RMS  ORMS  ELEV  T  P  H  CALIB  TB  RB  PRMS SCI
      mm  mm  mm  deg  C  mbar  %  mm  us  mm  mm  mm
7810 22.08.02 04:18 04:51 L2  26  25  105  120  162 025-080 11  913.6 99  12464  -10  91  119  0
```

Subj: No.2081 : Delft QL Report, August 27, 2002

```
-----
Date  Time  Sat.  Obs.  RMS  Range Bias  Time Bias  Scatter
      tot/rej  (mm)  (mm)  (us)  (mm)
-----
Station 7810 (Zimmerwald) (Position fixed, acc. 60 mm)
7810 22 Aug 02 04:18 LAG2 26 13 4 0 +- 88 1 +- 53 3
```